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Nakano

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(54) **IMAGE FORMING APPARATUS AND FIXING UNIT ATTACHABLE TO IMAGE FORMING APPARATUS**

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(52) **U.S. Cl.**
CPC ***G03G 15/2017*** (2013.01); *G03G 21/1652* (2013.01); *G03G 2215/2035* (2013.01)

(58) **Field of Classification Search**
CPC G03G 21/1652; G03G 2221/1639; G03G 2221/166; G03G 15/2017
USPC 399/88, 90, 122
See application file for complete search history.

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(57) **ABSTRACT**

The present invention provides an apparatus having a part of a current detecting circuit configured to detect current to a heater in a fixing unit so that a main body of the image forming apparatus may have one configuration for 100 V and 200 V and provides an equal resolution of current detection for an apparatus for 100 V and an apparatus for 200 V.

24 Claims, 10 Drawing Sheets

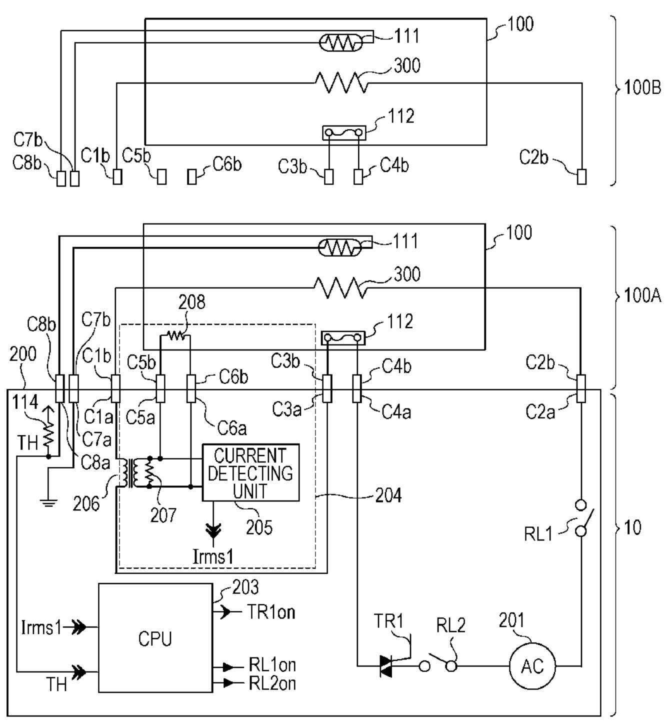


FIG. 1

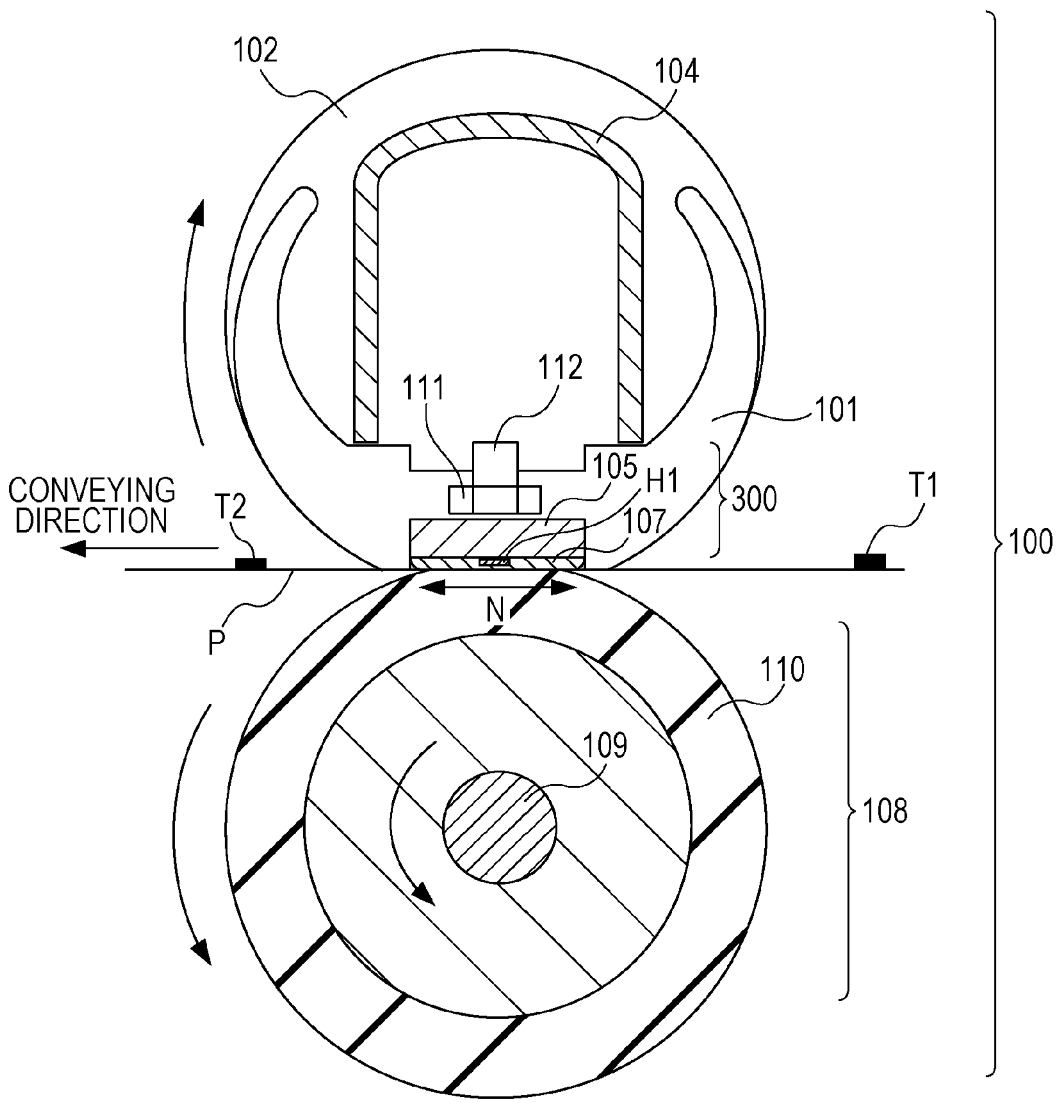

102
104
112
111
101
105
H1
300
107
CONVEYING DIRECTION
T2
T1
100
N
P
110
109
108

FIG. 2

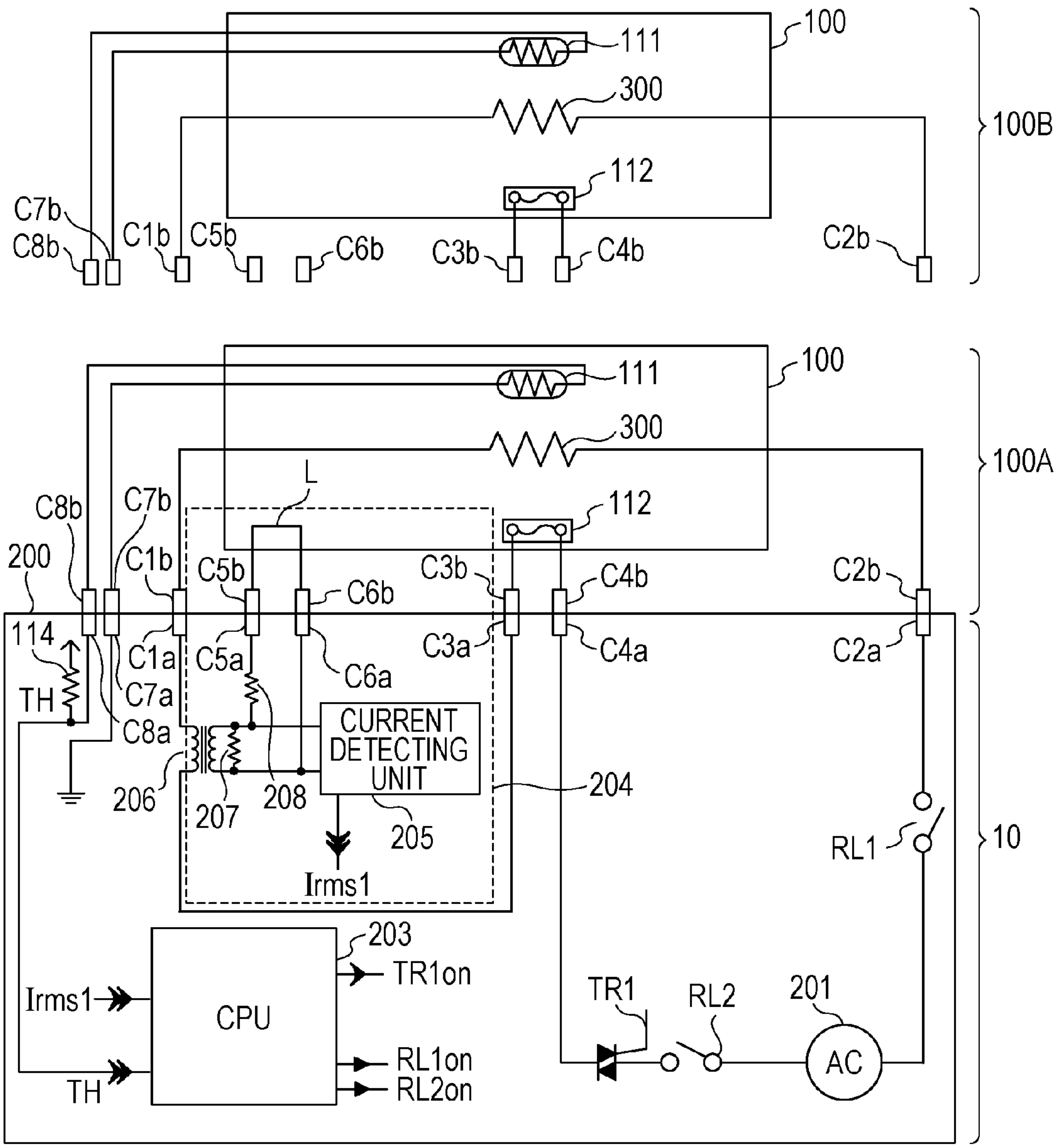

100
111
300
100B
112
C7b
C8b
C1b
C5b
C6b
C3b
C4b
C2b
100
111
300
100A
L
112
C8b
C7b
C1b
C5b
C6b
C3b
C4b
C2b
200
114
C1a
C5a
C6a
C3a
C4a
C2a
TH
C7a
C8a
CURRENT DETECTING UNIT
206
207
208
205
204
RL1
10
Irms1
203
TR1on
CPU
Irms1
TH
RL1on
RL2on
TR1
RL2
201
AC

FIG. 3

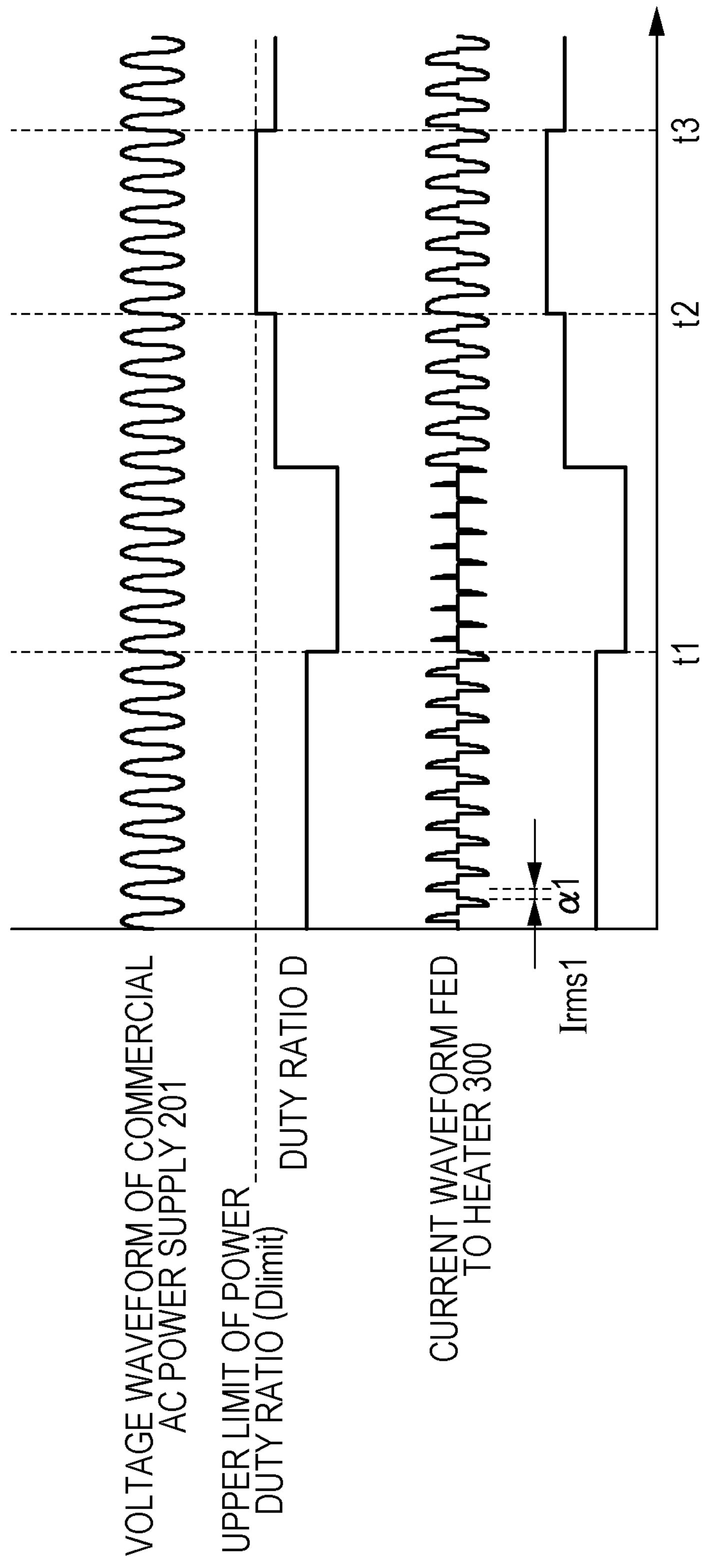

VOLTAGE WAVEFORM OF COMMERCIAL AC POWER SUPPLY 201
UPPER LIMIT OF POWER DUTY RATIO (Dlimit)
DUTY RATIO D
CURRENT WAVEFORM FED TO HEATER 300
Irms1
α1
t1
t2
t3

FIG. 4A

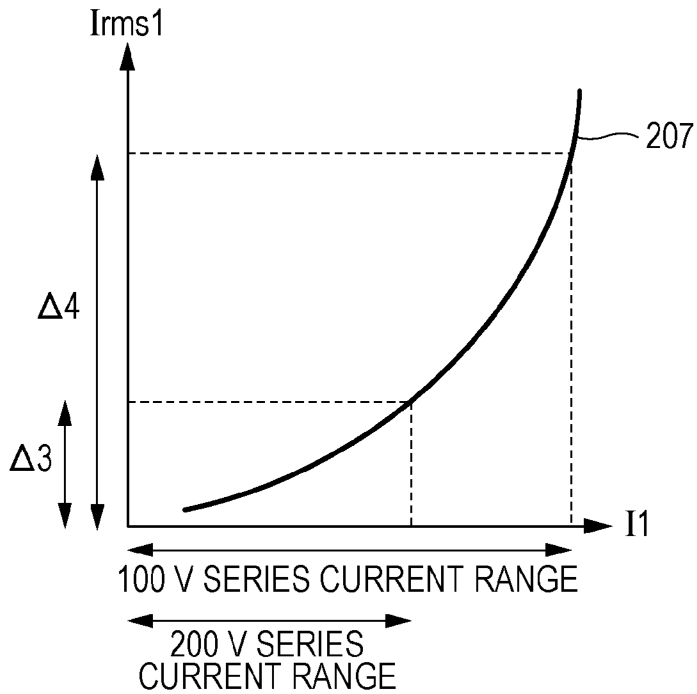

Irms1
207
Δ4
Δ3
I1
100 V SERIES CURRENT RANGE
200 V SERIES
CURRENT RANGE

FIG. 4B

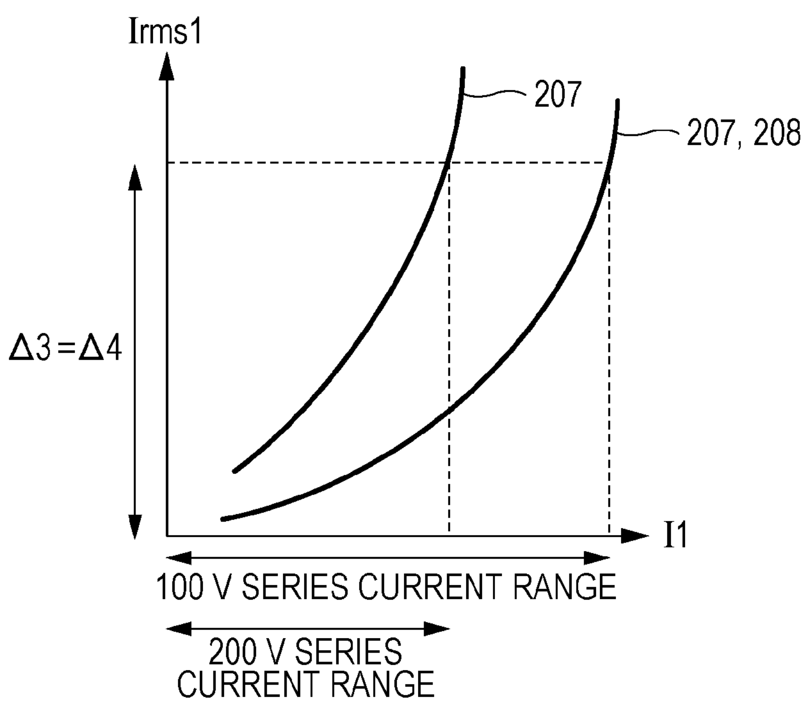

Irms1
207
207, 208
Δ3 = Δ4
I1
100 V SERIES CURRENT RANGE
200 V SERIES
CURRENT RANGE

FIG. 5

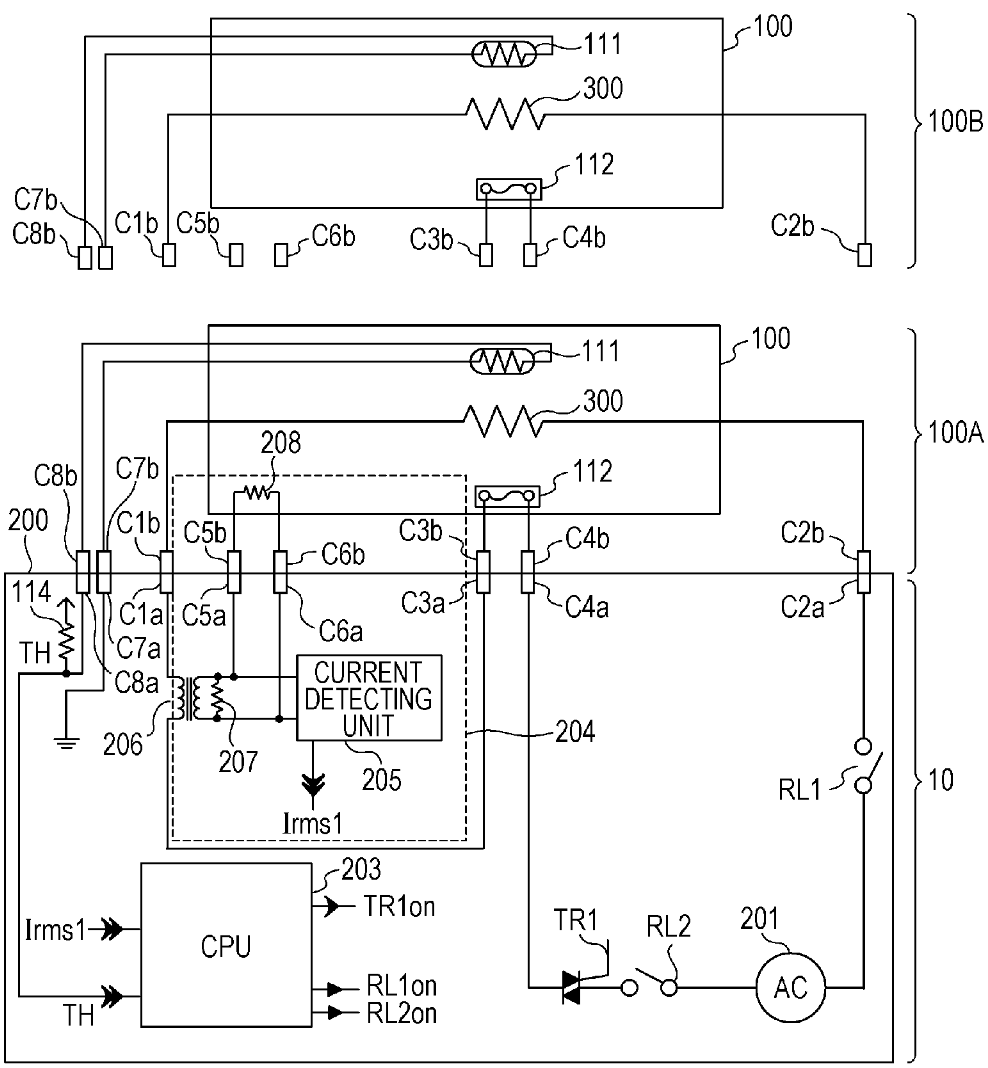

100
111
300
100B
112
C7b
C8b
C1b
C5b
C6b
C3b
C4b
C2b
100A
208
C8b
C7b
200
C1b
C5b
C6b
C3b
C4b
C2b
114
C1a
C5a
C3a
C4a
C2a
TH
C7a
C6a
C8a
CURRENT DETECTING UNIT
206
207
205
204
Irms1
RL1
10
203
TR1on
Irms1
CPU
TR1
RL2
201
AC
TH
RL1on
RL2on

FIG. 6

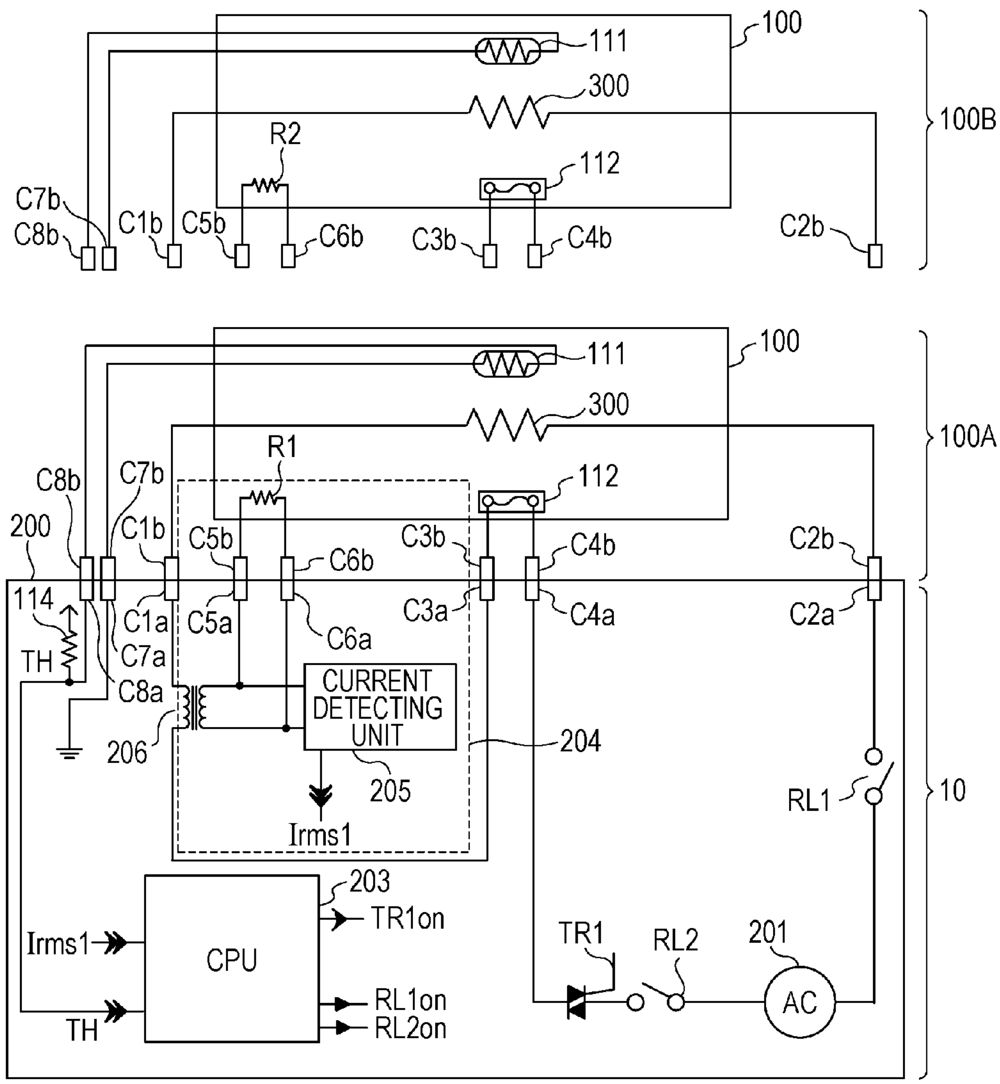
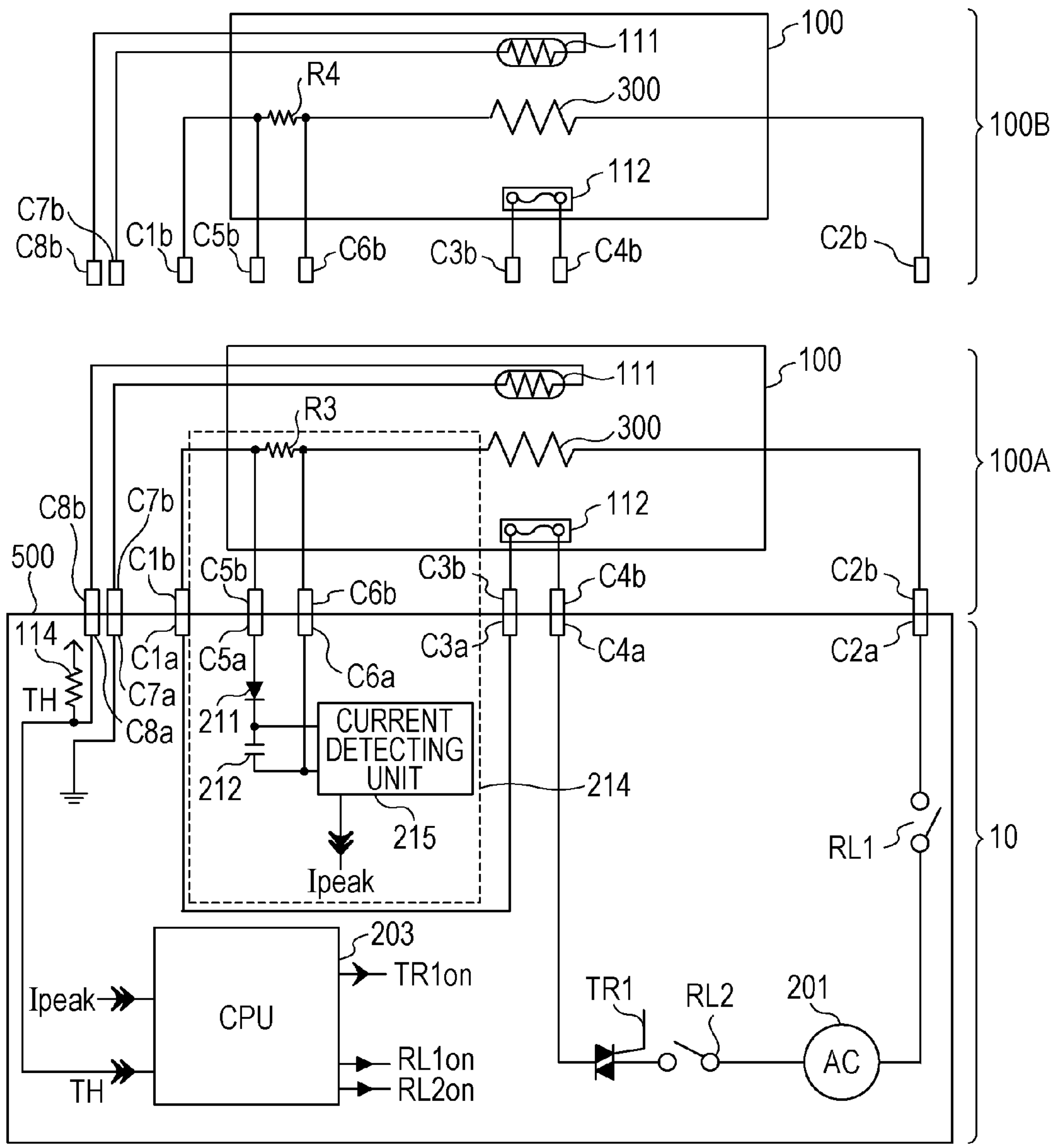

100
111
300
100B
R2
112
C7b
C8b
C1b
C5b
C6b
C3b
C4b
C2b
100
111
300
100A
R1
112
C8b
C7b
200
C1b
C5b
C6b
C3b
C4b
C2b
114
C1a
C5a
C6a
C3a
C4a
C2a
TH
C7a
C8a
CURRENT DETECTING UNIT
206
204
205
Irms1
RL1
10
203
TR1on
CPU
Irms1
TR1
RL2
201
AC
TH
RL1on
RL2on

FIG. 7



100
111
R4
300
100B
112
C7b
C8b
C1b
C5b
C6b
C3b
C4b
C2b
100
111
R3
300
100A
112
C8b
C7b
500
C1b
C5b
C6b
C3b
C4b
C2b
114
C1a
C5a
C3a
C4a
C2a
TH
C7a
C6a
C8a
211
212
CURRENT DETECTING UNIT
214
215
Ipeak
RL1
10
203
TR1on
CPU
Ipeak
TH
RL1on
RL2on
TR1
RL2
201
AC

FIG. 8

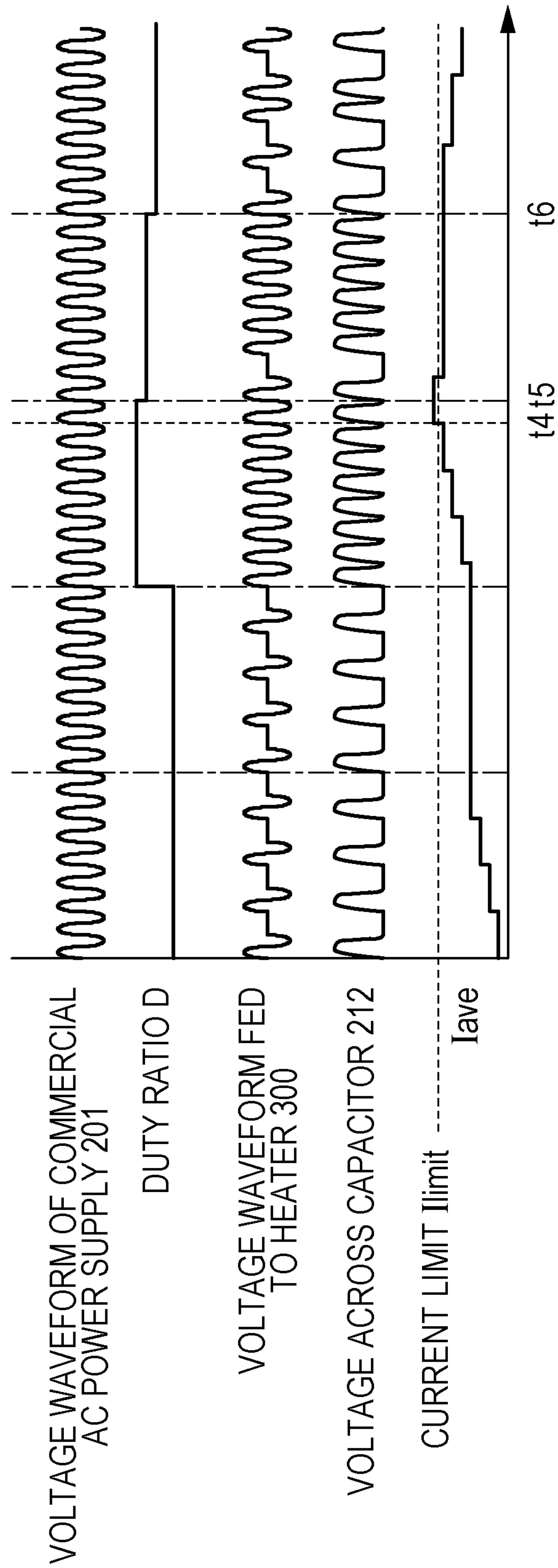

VOLTAGE WAVEFORM OF COMMERCIAL AC POWER SUPPLY 201
DUTY RATIO D
VOLTAGE WAVEFORM FED TO HEATER 300
VOLTAGE ACROSS CAPACITOR 212
CURRENT LIMIT Ilimit
Iave
t4
t5
t6

FIG. 9A

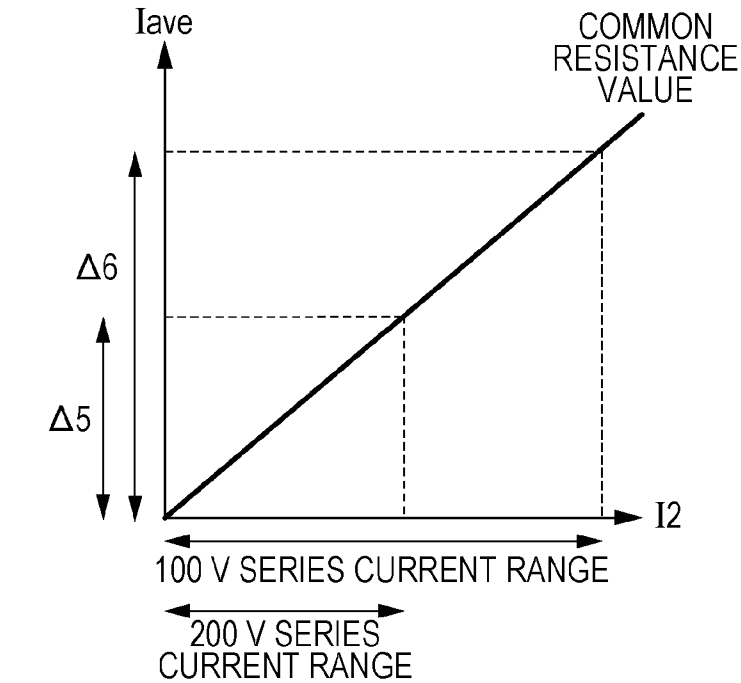

Iave
COMMON
RESISTANCE
VALUE
Δ6
Δ5
I2
100 V SERIES CURRENT RANGE
200 V SERIES
CURRENT RANGE

FIG. 9B

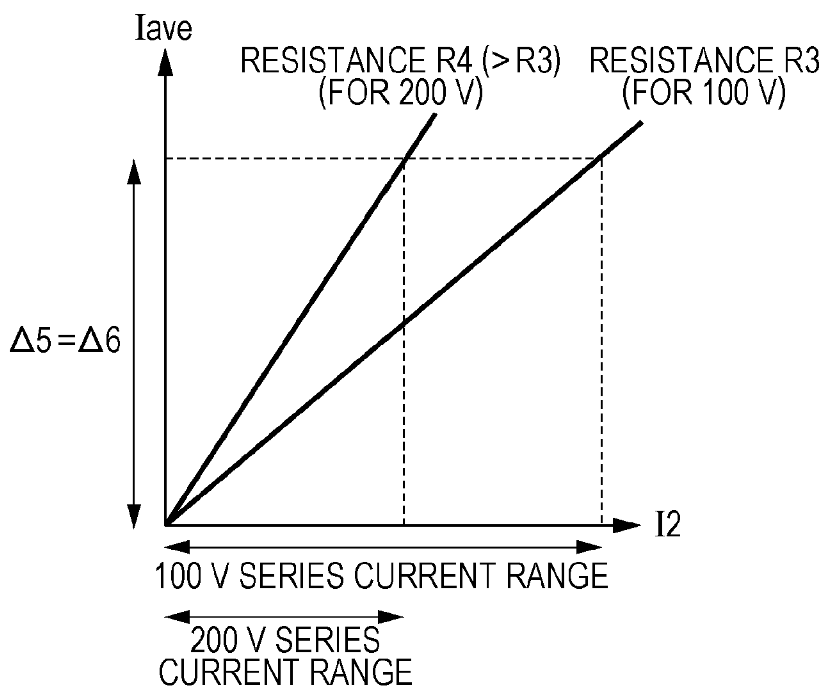

Iave
RESISTANCE R4 (>R3)
(FOR 200 V)
RESISTANCE R3
(FOR 100 V)
Δ5=Δ6
I2
100 V SERIES CURRENT RANGE
200 V SERIES
CURRENT RANGE

FIG. 10

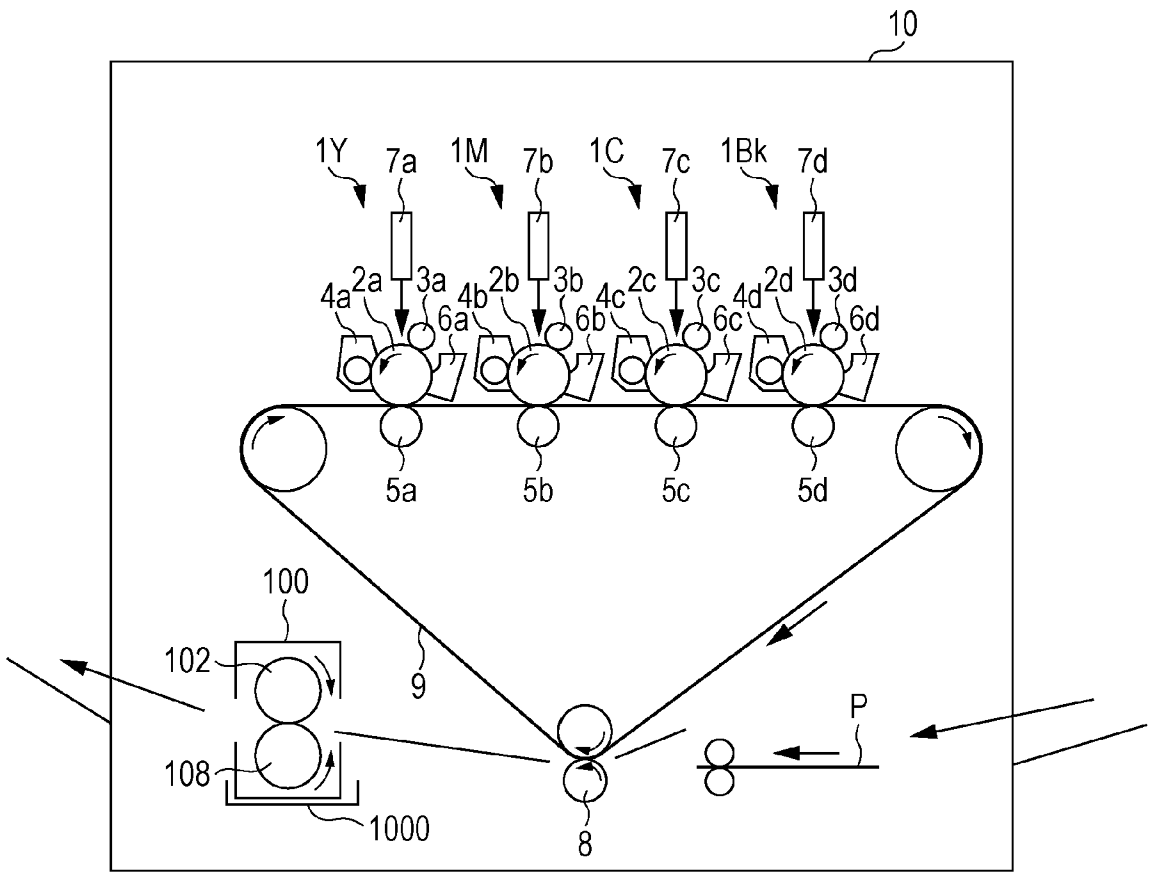

10
1Y
7a
1M
7b
1C
7c
1Bk
7d
4a
2a
3a
6a
4b
2b
3b
6b
4c
2c
3c
6c
4d
2d
3d
6d
5a
5b
5c
5d
100
102
9
P
108
1000
8

IMAGE FORMING APPARATUS AND FIXING UNIT ATTACHABLE TO IMAGE FORMING APPARATUS

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to image forming apparatuses applying an electrophotography recording technology and fixing units each attachable to an image forming apparatus.

2. Description of the Related Art

In some cases, one model of image forming apparatus may be designed to be usable both in a district where commercial power supply voltage is 100 V series (such as 100 V to 127 V) and in a district where it is 200 V series (such as 220 V to 240 V). An image forming apparatus applying an electrophotography recording technology may include a fixing unit configured to heat-fix an unfixed toner image formed on a recording material to the recording material. In order to allow the fixing unit to be usable in districts with different power supply voltages, a resistance value of a heater in the fixing unit may need adjustment based on the power supply voltage in each of the districts. This is because resistance values of heaters not based on power supply voltages may result in variations of amount of heat generated by the heater between the districts.

For setting a resistance value of a heater based on power supply voltage, heaters having different resistance values from each other may be mounted correspondingly in an apparatus for a 100 V district and an apparatus for a 200 V district (as in Japanese Patent Laid-Open No. 9-022224). For example, a heater having a resistance value of 10Ω may be mounted in an apparatus for a 100 V district while a heater having a resistance value of 40Ω may be mounted in an apparatus for a 200 V district. Though this method may require two types of heater, an apparatus for 100 V and an apparatus for 200 V may advantageously be manufactured at low costs.

By the way, the speeds of such image forming apparatuses have been enhanced in recent years, and some apparatuses may include a current detection function configured to detect current fed to the heater to support such increased speeds of the image forming apparatus. The current detection function may detect current fed to the heater and thus is usable for applications such as monitoring for prevention of supply of excessive power to the heater.

The ranges of values of current fed to heaters may be different between an apparatus for 100 V and an apparatus for 200 V as described above. For example, when an apparatus including a heater having a resistance value of 10Ω for 100 V is used by connecting to 100 V power supply voltage, the power consumption may be equal to 1000 W at a maximum, and the range of current values fed to the heater is equal to 0 to 10 A. When an apparatus including a heater having a resistance value of 40Ω for 200 V is used by connecting to power supply voltage 200 V, the power consumption may be equal to 1000 W at a maximum, and the range of current values fed to the heater (which will be called a heater current value) is equal to 0 to 5 A.

The ranges of heater current values in an apparatus for 100 V and the range of heater current values in an apparatus for 200 V are different. Among image forming apparatuses having a current detection function, such different ranges of heater current values may result in different resolutions of the current detection and thus result in different accuracies of the current detection between the apparatus for 100 V and the apparatus for 200 V.

Accordingly, it may be considered that an element (such as a resistance element) for prevention of such a difference in resolution for current detection between an apparatus for 100 V and an apparatus for 200 V may be attached to a main body of the apparatus for 100 V only while not attaching to a main body of the apparatus for 200 V.

However, in order to manufacture an apparatus for 100 V and an apparatus for 200 V, not only two types of fixing unit for 100 V and 200 V may be required therein, but also two types of apparatus main bodies may be required for 100 V and 200 V. This may complicate unit management during the manufacturing process and may thus increase the manufacturing costs.

SUMMARY OF THE INVENTION

The present invention provides an image forming apparatus and a fixing unit attachable to an image forming apparatus, which may achieve reduced variations of accuracy of current detection between an apparatus for 100 V and an apparatus for 200 V and reduced manufacturing costs.

According to another aspect of the present invention, there is provided an image forming apparatus including:

an apparatus main body to which a first fixing unit having a heater corresponding to a 100 V series commercial power supply and a second fixing unit having a heater corresponding to a 200 V series commercial power supply are exchangeably attachable; and

a current detecting circuit provided in the apparatus main body, the current detecting circuit detecting current fed to the first fixing unit or the second fixing unit attached to the apparatus main body,

wherein an unfixed image formed on a recording material is fixed to the recording material with heat from a heater in the first fixing unit or the second fixing unit attached to the apparatus main body,

wherein at least one of the first fixing unit and the second fixing unit has a part of the current detecting circuit, and

wherein the apparatus main body has a connector configured to connect the part of the current detecting circuit and the current detecting circuit provided in the apparatus main body.

According to another aspect of the present invention, there is provided an image forming apparatus including:

a fixing unit having a heater configured to generate heat with power supplied from a commercial power supply, the fixing unit being configured to fix an unfixed image formed on a recording material to the recording material with heat from the heater;

a current detecting circuit configured to detect current fed to the heater; and

an apparatus main body configured to accommodate the current detecting circuit,

wherein the fixing unit is attachable to the apparatus main body, and

wherein a part of the current detecting circuit is provided in the fixing unit.

According to another aspect of the present invention, there is provided a fixing unit including:

a heater configured to generate heat with power supplied from a commercial power supply,

wherein the image forming apparatus has a current detecting circuit configured to detect current fed to the heater, and

wherein the fixing unit has a part of the current detecting circuit.

Further features of the present invention will become apparent from the following description of exemplary embodiments with reference to the attached drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a cross section view of a fixing unit.

FIG. **2** illustrates a heater control circuit according to a first exemplary embodiment.

FIG. **3** is a relation diagram between current fed to a heater, duty ratio, and so on.

FIGS. **4**A and **4**B illustrate relationships between effective value of current fed to a heater and square value of a current effective value to be output to a CPU.

FIG. **5** illustrates a first variation example of the first exemplary embodiment.

FIG. **6** illustrates a second variation example of the first exemplary embodiment.

FIG. **7** is a heater control circuit diagram according to a second exemplary embodiment.

FIG. **8** is a relation diagram of current fed to a heater, duty ratio and so on.

FIGS. **9**A and **9**B illustrate relationships between effective value of current fed to a heater and moving average current to be output to a CPU.

FIG. **10** is a cross section view of an image forming apparatus.

DESCRIPTION OF THE EMBODIMENTS

First Exemplary Embodiment

FIG. **10** is a cross section view of a full-color image forming apparatus **10** applying an electrophotography recording technology. An image forming unit configured to form an unfixed toner image on a recording material P has four image forming stations (**1**Y, **1**M, **1**C, **1**Bk). Each of the image forming stations has a photosensitive member **2** (**2***a*, **2***b*, **2***c*, **2***d*), a charging member **3** (**3***a*, **3***b*, **3***c*, **3***d*) configured to charge the photosensitive member, and a laser scanner **7** (**7***a*, **7***b*, **7***c*, **7***d*) configured to form an electrostatic latent image based on image information on the charged photosensitive member. Each of the image forming stations further has a developing device **4** (**4***a*, **4***b*, **4***c*, **4***d*) configured to develop an electrostatic latent image by using toner, a transferring member **5** (**5***a*, **5***b*, **5***c*, **5***d*) configured to transfer toner image from the photosensitive member to an intermediate transfer belt **9**, and a cleaner **6** (**6***a*, **6***b*, **6***c*, **6***d*) configured to clean the photosensitive member. The image forming unit further includes the intermediate transfer belt **9** and a secondary transferring member **8** configured to transfer a toner image from the belt **9** to the recording material P, in addition to the four image forming stations. Because the operations of the image forming unit are well known, the detail description will be omitted. The recording material P to which an unfixed toner image is transferred in the image forming unit is passed to a fixing unit **100**, undergoes a fixing process and then is discharged externally to the apparatus. The fixing unit **100** is detachable from an attachment **1000** provided in an apparatus main body **10**.

FIG. **1** is a cross section view of the fixing unit **100** having a heater **300** configured to generate heat with power supplied from commercial power supply and fix an unfixed toner image (unfixed image) T**1** formed on the recording material P to the recording material P by using heat from the heater **300**.

The fixing unit **100** has a tubular film **102**, the heater **300** in contact with an inner surface of the film **102**, and a roller (nip portion forming member) **108** configured to form a fixing nip portion N through the film **102** together with the heater **300**. A base layer of the film is formed of a material such as polyimide or other heat-resistant resin or stainless or other metal. The roller **108** has a shaft **109** formed of a material such as iron and aluminum and an elastic layer **110** formed of a material such as silicone rubber. The heater **300** is held by a holding member **101** formed of a heat-resistant resin. The holding member **101** has a guiding function configured to guide rotation of the film **102**. The roller **108** rotated in the direction indicated by the arrows in FIG. **1** by power supplied from a motor, not illustrated. The film **102** rotates by following the rotation of the roller **108**.

The heater **300** has a heater substrate **105** formed of ceramic, a heating element H**1** formed on a heater substrate **105**, and an insulating surface protecting layer **107** (of glass according to this exemplary embodiment) which covers the heating element H**1**. A temperature detection element **111** such as a thermistor is abutted on a paper feeding region of a back surface of the heater substrate **105** for usable minimum size paper (an envelope DL: 110 mm wide in the present example) set to the image forming apparatus. The power to be supplied from a commercial AC power supply to the heater **300** is controlled based on a temperature detected by the temperature detection element **111**. The recording material P bearing unfixed toner image T**1** is pinched and conveyed by the fixing nip portion N and is heated for fixing. FIG. **1** illustrates a toner image T**2** after the fixing process. A safety element **112** such as a thermal switch is also abutted on the back surface of the heater substrate **105**. The safety element **112** operates to shut down a feeder (power supply path) to the heater **300** when the temperature of the heater **300** rises abnormally. The safety element **112** is also abutted on the paper feeding region for minimum size paper, like the temperature detection element **111**. A metallic stay **104** applies pressure from a spring, not illustrated, to the holding member **101**.

FIG. **2** illustrates the fixing unit **100** and a heater control circuit **200**. The heater control circuit **200** is provided within the apparatus main body **10**. A fixing unit (first fixing unit) **100**A and a fixing unit (second fixing unit) **100**B may be exchangeably attached to the apparatus main body **10**. The fixing unit **100**A has a heater corresponding to a 100 V series commercial power supply. The fixing unit **100**B has a heater corresponding to a 200 V series commercial power supply. The apparatus main body **10** has an identical configuration for districts of 100 V series and districts of 200 V series.

Connectors C**1** (C**1***a*+C**1***b*), C**2** (C**2***a*+C**2***b*), C**3** (C**3***a*+C**3***b*), and C**4** (C**4***a*+C**4***b*) connect the control circuit **200** and the heater **300** (forming a power supply path to the heater). Connectors C**7** (C**7***a*+C**7***b*) and C**8** (C**8***a*+C**8***b*) connect the control circuit **200** and the temperature detection element **111**. FIG. **1** further illustrates a commercial AC power supply **201**. Relays RL**1** and RL**2** switch the power application/shut down to the heater **300**. FIG. **2** illustrates a state (shut down state) of the relays in a case where the image forming apparatus has a power off state. The power control over the heater **300** may be implemented by bringing the relays RL**1** and RL**2** into a conductive state for power application/shut down to a triac TR**1** (semiconductor drive element). The triac TR**1** operates in response to a heater drive signal TR**1***on* from a CPU **203**. A temperature is detected by the temperature detection element **111** as a partial pressure of a pull-up electrical resistance **114** and is input as a TH signal to the CPU **203**. The CPU **203** calculates power to be supplied by using PI control, for example, based on the temperature detected by the temperature detection element **111** and a set temperature (control target temperature) of the heater **300**. A heater drive signal

TR1*on* indicative of a phase angle based on the calculated power is transmitted to the triac TR1 to control the triac TR1. Under such control, the heater **300** may be kept at a set temperature during a fixing process. When a temperature detected by the temperature detection element **111** is higher than a predetermined upper limit temperature, an abnormal temperature rise is judged, and the relays RL**1** and RL**2** are shut down.

Next, a current detecting circuit **204** will be described. The current detecting circuit **204** of this exemplary embodiment is provided for monitoring to prevent supply of an excessive amount of power to the heater **300** and is accommodated in the apparatus main body.

The current detecting circuit **204** is provided in the power supply path to the heater **300**, as illustrated in FIG. **2**. The current detecting circuit **204** passes the current flowing through the primary side (power supply path to the heater) to the secondary side through a current transformer **206**, and an electrical resistance **207** performs I-V conversion (current-voltage conversion) thereon, and the result is input to a current detecting unit **205**. The current detecting unit **205** has a multiplier internally and outputs a signal Irms**1** indicative of a square value of a current effective value to the CPU **203** for each one cycle of a commercial AC waveform. The current detecting unit **205** may be an IC (Integrated Circuit) chip, for example. The CPU **203** detects a current effective value for each one cycle of a commercial AC waveform from the signal Irms**1**. The current detecting circuit **204** may have a configuration as disclosed in Japanese Patent No. 4920985, for example. Outputting a square value of a current effective value as described above advantageously allows easy calculation of the amount of power to be fed to the heater **300**.

The CPU **203** uses the signal Irms**1** to limit the power to be supplied to the heater **300** to 1000 W or lower, for example. In an apparatus for 100 V to which the first fixing unit mounting a heater having a resistance value of 10Ω is connected, power higher than 1000 W may be detected from current higher than 10 A flowing through the power supply path to the heater. In other words, the upper limit Ilimit of current may be set to 10 A for an image forming apparatus for 100 V to which the first fixing unit is connected. In an apparatus for 200 V to which the second fixing unit mounting a heater having a resistance value of 40Ω is connected, current higher than 5 A flowing through the power supply path to the heater maybe detected. In other words, the upper limit Ilimit of current may be set to 5 A for an image forming apparatus for 200 V to which the second fixing unit is connected.

According to this embodiment, for controlling power to be supplied to the heater to a predetermined amount of power or lower by using a current detection result, the following method is applied.

First, power is supplied to the heater **300** at a predetermined fixed duty ratio D**1**. A TR**1***on* signal having a phase angle α**1** corresponding to the fixed duty ratio D**1** is transmitted from the CPU **203** to the triac TR**1**, and the triac TR**1** is turned on with the phase angle α**1**. Thus, current turned on with the phase angle α**1** is fed to the heater **300** (see FIG. **3**). A current effective value I**1** is detected from a signal Irms**1** output from the current detecting unit **205** when power is supplied at the fixed duty ratio D**1**. From the detected current effective value I**1**, the fixed duty ratio D**1**, and a preset current limit Ilimit, the CPU **203** calculates a power duty ratio Dlimit that is an upper limit for allowing power supply to the heater by using the following expression (1):

$$D\text{limit}=(I\text{limit}/I1)^2\times D1 \tag{1}$$

FIG. **3** illustrates a relationship among a voltage waveform of the commercial AC power supply **201**, an upper limit of power duty ratio Dlimit, a duty ratio D of power to be actually supplied to the heater, a waveform of current fed to the heater **300**, and a square value Irms**1** of the current effective value. In a period to a time t**1**, power is supplied to the heater **300** at the fixed duty ratio D**1**, and the upper limit of power duty ratio Dlimit is calculated. From the time t**1**, control for keeping the heater **300** at a set temperature starts. The control supplies power at a duty ratio D calculated based on a comparison result between a temperature detected by the temperature detection element **111** and a set temperature (control target temperature), as described above. FIG. **3** illustrates a case where the duty ratio D calculated based on a comparison result between the temperature detected by the temperature detection element **111** and the set temperature (control target temperature) is equal to or higher than the upper limit of power duty ratio Dlimit during a period from a time t**2** to a time t**3**. For example, this may be a case where the power required for keeping the heater at the set temperature is equal to 1100 W. In this case, the duty ratio D for power to be actually supplied is limited to the upper limit of power duty ratio Dlimit. This control may prevent the supply power from exceeding 1000 W. At the time t**3**, when the duty ratio D calculated based on a comparison result between the temperature detected by the temperature detection element **111** and the set temperature is lower than the upper limit of power duty ratio Dlimit, power is supplied at the calculated duty ratio D. As being understood from FIG. **2**, the square value Irms**1** of the current effective value has duty ratio D are identical in behavior.

FIG. **4**A illustrates a relationship between the current effective value I**1** of current fed to the primary side of the current transformer **206** and the square value Irms**1** of the current effective value output to the CPU **203**. As illustrated in FIG. **4**A, the resolution for Irms**1** is higher in a region having higher I**1** while the resolution for Irms is lower in a region having lower I**1**, influencing on the accuracy of detection of the current effective value. As described above, the range (0 to 10 A) of the heater current value in an apparatus for 100 V and the range (0 to 5 A) of the heater current value in an apparatus for 200 V are different. Thus, the resolution for current detection is lower in an apparatus for 200 V than that in an apparatus for 100 V.

The electrical resistance **207** is an electrical resistance (resistance element) configured to perform I-V conversion. Assuming an equal magnitude of the current effective value I**1**, as the value of the electrical resistance **207** decreases, the square value Irms**1** of the current effective value against the current effective value I**1** decreases. In other words, in an apparatus for 200 V, the resistance value of the electrical resistance **207** may be increased to increase the square value Irms**1** of the current effective value against the current effective value I**1**. In an apparatus for 100 V, the square value Irms**1** of the current effective value may be kept within an allowable input voltage range of the CPU **203** by reducing the electrical resistance **207** to prevent an excessive increase of the square value Irms**1** of the current effective value against the current effective value I**1**.

To keep equal current detection performance between an apparatus for 100 V and an apparatus for 200 V, the resistance value of the electrical resistance which performs I-V conversion may be required to change. However, attaching the electrical resistances **207** having different values to a main body of an apparatus for 100 V and a main body of an apparatus for 200 V may result in different configurations between the main body of the apparatus for 100 V and the main body of the apparatus for 200 V. This may require not only two types of fixing unit for 100 V and 200 V but also two types of apparatus main bodies for 100 V and 200 V. Therefore, the unit management may be more complicated during the production process.

According to this exemplary embodiment, a part (L illustrated in FIG. 2) of the current detecting circuit is provided in the fixing unit. Connectors C5*a* and C6*a* in FIG. 2 are provided for switching the parallel connection through the fixing unit **100** between a plurality of resistance elements of the electrical resistance **207** and electrical resistance **208** which perform I-V conversion. In other words, the connectors C5*a* and C6*a* are provided for connecting the part (L in FIG. 2) of the current detecting circuit provided in the fixing unit to the current detecting circuit provided in the apparatus main body. The connectors C5*a* and C6*a* are provided in the apparatus main body. The fixing unit includes connectors C5*b* and C6*b* which connect the connectors C5*a* and C6*a*. The part L of the current detecting circuit is provided in a first fixing unit **100**A for 100 V. When the connectors C5*b* and C6*b* in the fixing unit for 100 V is connected to the connectors C5*a* and C6*a* in the apparatus main body, a circuit through the electrical resistance **208** is formed, and the electrical resistance **207** and the electrical resistance **208** are connected in parallel, resulting in a lower synthesized resistance value. On the other hand, a second fixing unit **100**B for 200 V does not have the part L of the current detecting circuit. Alternatively, the second fixing unit may be implemented by connecting a resistance element having a sufficiently high value against the electrical resistance **207** to the electrical resistance **207** in parallel so that the influence on the electrical resistance **208** may be suppressed, which is equivalent to the I-V conversion performed by the electrical resistance **207** only. Selecting the values of the electrical resistance **207** and electrical resistance **208** based on commercial power supply voltage may allow generation of Irms**1** that fits to power supply voltage by changing the gain of the I-V conversion for each power supply voltage. According to this exemplary embodiment, the second fixing unit **100**B for 200 V may not necessarily include the part L of the current detecting circuit, as described above. In this case, the fixing-unit side connectors C5*b* and C6*b* may not be provided in the second fixing unit but may be in the first fixing unit only to connect to the connectors C5*a* and C6*a* in the apparatus main body. Therefore, a part of the current detecting circuit may be provided in at least one of the first fixing unit and the second fixing unit. In the image forming apparatus of this embodiment, the configuration of the current detecting circuit may vary in accordance with the fixing unit to be attached.

FIG. 4B illustrates a relationship between a current effective value I**1** and the square value Irms**1** of the current effective value when the electrical resistance for I-V conversion is adjusted in accordance with power supply voltage. Referring to FIG. 4B, the resistance value of the electrical resistance **207** exhibiting the characteristic illustrated in FIG. 4A is increased to improve the resolution of current detection in an apparatus for 200 V. However, a high resistance value of the electrical resistance **207** may result in an excessively high value of Irms**1** against I**1** in an apparatus for 100 V beyond the allowable input voltage range of the CPU **203**. Accordingly, a part L of a circuit for parallel connection between the electrical resistance **207** and the electrical resistance **208** is provided in the fixing unit for 100 V for reducing the synthesized electrical resistance of the electrical resistances which perform IV conversion. This may achieve an improved resolution of current detection in the apparatus for 200 V and an equal resolution of current detection ($\Delta3=\Delta4$) in the apparatus for 100 V and the apparatus for 200 V.

According to this exemplary embodiment, two types of fixing unit for 100 V and 200 V may only be required but the apparatus main body **10** may have an identical configuration both for 100 V and 200 V. This may simplify the unit management during the production process and may reduce the production costs. Furthermore, there may be provided an image forming apparatus and a fixing unit attachable to an image forming apparatus, which may exhibit a small difference in accuracy of current detection between an apparatus for 100 V and an apparatus for 200 V and may be produced at reduced costs. For achieving this, a part of the current detecting circuit may be provided in at least one of the first fixing unit and the second fixing unit. A connector for connecting the part of the current detecting circuit provided in the fixing unit to the current detecting circuit provided in the apparatus main body may be provided in the apparatus main body.

FIG. **5** illustrates a first variation example of the first exemplary embodiment. While the electrical resistance **208** is provided in the apparatus main body **10** in the example illustrated in FIG. **2**, the electrical resistance **208** is provided in the fixing unit in the example illustrated in FIG. **5**.

FIG. **6** illustrates a second variation example of the first exemplary embodiment. In this example, both of the apparatus for 100 V and the apparatus for 200 V may have only one electrical resistance which performs I-V conversion. The relationship of the resistance value between an electrical resistance R**1** and an electrical resistance R**2** satisfies R**1**<R**2**.

The configurations illustrated in FIG. **5** and FIG. **6** may also achieve an improved resolution of current detection in the apparatus for 200 V and an equal resolution of current detection in the apparatus for 100 V and the apparatus for 200 V. The apparatus main bodies for 100 V and 200 V may have an identical configuration. This may simplify the unit management during the production process and may reduce the production costs.

Second Exemplary Embodiment

FIG. **7** illustrates a heater control circuit **500** according to a second exemplary embodiment. Like reference numerals and signs refer to like parts between the first and second exemplary embodiments.

According to this exemplary embodiment, a current detection electrical resistance R**3** (R**4**) is provided in a power supply path to a heater, instead of the current transformer **206** according to the first exemplary embodiment. The current detection electrical resistance R**3** (R**4**) is provided within a fixing unit. In other words, a part of a current detecting circuit is provided in the fixing unit, like the first exemplary embodiment.

The CPU **203** performs power control based on a peak voltage value occurring in the current detection electrical resistance R**3** (R**4**) and a frequency of generation of voltage. A current value for one wave fed to the heater **300** is calculated from a peak voltage value, and an average current value is calculated from the frequency of generation of voltage. The current detection electrical resistance R**4** within the second fixing unit **100**B for 200 V may be set to double the value of the current detection electrical resistance R**3** within the first fixing unit **100**A for 100 V. This may achieve an improved resolution of current detection in the apparatus for 200 V and an equal resolution of current detection in the apparatus for 100 V and the apparatus for 200 V. Furthermore, power control based on commercial power supply voltage may be achieved.

The current detecting circuit **214** according to this embodiment further includes a rectifier diode **211**, a capacitor **212**, and a current detecting unit **215**, in addition to the current detection electrical resistance R**3** (R**4**). The current detection electrical resistance R**3** (R**4**) is provided in the power supply path to the heater **300**, as illustrated in FIG. **7**. When current is fed to the heater **300**, the current detection electrical resistance R**3** (R**4**) performs I-V conversion thereon. A peak of the I-V converted voltage is held by the rectifier diode **211** and capacitor **212**. The current detecting unit **215** internally has an amplifier and a converter and outputs a current peak value Ipeak every cycle of a commercial AC waveform. The CPU **203** detects from the peak value Ipeak a peak value of current I**2** fed to the heater **300** every cycle of a commercial AC waveform. The CPU **203** further detects the number of times of observation of the peak value Ipeak and calculates a moving average current lave for eight full waves (eight cycles of an AC waveform), for example, from the current peak value and the frequency. To keep power to be supplied to the heater **300** at a desirable level or lower, power control may be performed such that the moving average current Iave may be equal to or lower than a current limit Ilimit based on the resistance value of the heater **300**.

FIG. **8** illustrates a relationship among the voltage waveform of the commercial AC power supply **201**, a duty ratio D of power actually supplied to the heater, a current waveform fed to the heater **300**, voltage across the capacitor **212**, a current limit Ilimit, and a moving average current Iave. According to this exemplary embodiment, waveform control is performed by handling eight full waves as one unit, and a control update time occurs every eight full waves. The moving average current Iave changes in accordance with the voltage across the capacitor **212** and the frequency and is a moving average current value for eight full wave periods. When the voltage of the commercial AC power supply **201** is low, the current fed to the heater **300** is also low. Therefore, the voltage across the capacitor **212** is low, and the Iave value is also low. When the frequency of observation of the Ipeak is low, the Iave value is also low.

At a time t**4**, it is detected that the moving average current Iave exceeds the current limit Ilimit. At the next control update time t**5**, the duty ratio D is reduced. Reduction of the duty ratio D allows power equal to or smaller than desirable power to be supplied to the heater **300**.

FIG. **9**A illustrates a relationship between a current value I**2** fed to the heater **300** and the moving average current Iave output to the CPU **203**. As illustrated in FIG. **9**A, the current detection electrical resistance with a wider current range for an apparatus for 100 V may be used for an apparatus for 200 V so that the Iave resolution Δ5 may be reduced. On the other hand, as illustrated in FIG. **9**B, use of the current detection electrical resistance for an apparatus for 200 V allows current detection with higher accuracy for an apparatus for 200 V.

According to this exemplary embodiment, changing the current detection electrical resistance within the fixing unit **100** in accordance with power supply voltage may achieve current detection with high accuracy, which further allows more stable power control. Fixing units for 100 V and 200 V may only be required but the apparatus main body **10** may have an identical configuration both for 100 V and 200 V. This may simplify the unit management during the production process and may reduce the production costs. According to this exemplary embodiment, a current limit Ilimit is set to change the duty ratio D. However, a target value of supply power to the fixing unit **100** may be predefined, and the duty ratio D may be controlled in accordance with the target value and Iave.

The configuration of the second exemplary embodiment may also achieve an improved resolution of current detection in the apparatus for 200 V and an equal resolution of current detection in the apparatus for 100 V and the apparatus for 200 V. The apparatus main bodies for 100 V and 200 V may have an identical configuration. This may simplify the unit management during the production process and may reduce the production costs.

While the present invention has been described with reference to exemplary embodiments, it is to be understood that the invention is not limited to the disclosed exemplary embodiments. The scope of the following claims is to be accorded the broadest interpretation so as to encompass all such modifications and equivalent structures and functions.

This application claims the benefit of Japanese Patent Application No. 2013-125715 filed Jun. 14, 2013, which is hereby incorporated by reference herein in its entirety.

What is claimed is:

1. An image forming apparatus comprising:

an apparatus main body to which a first fixing unit having a heater corresponding to a 100 V series commercial power supply and a second fixing unit having a heater corresponding to a 200 V series commercial power supply are exchangeably attachable; and

a current detecting circuit provided in the apparatus main body, the current detecting circuit detecting current fed to the heater in the first fixing unit or the second fixing unit attached to the apparatus main body,

wherein an unfixed image formed on a recording material is fixed to the recording material with heat from the heater in the first fixing unit or the second fixing unit attached to the apparatus main body,

wherein the current detecting circuit detects current fed to the heater through a current transformer that includes a primary side and a secondary side,

wherein at least one of the first fixing unit and the second fixing unit has a part of the current detecting circuit provided in the secondary side of the current transformer, and

wherein the apparatus main body has a first connector configured to connect the commercial power supply and the heater in the first fixing unit or the second fixing unit, and a second connector configured to connect the part of the current detecting circuit provided in the secondary side of the current transformer and the current detecting circuit provided in the secondary side of the current transformer provided in the apparatus main body.

2. The image forming apparatus according to claim **1**, wherein the current detecting circuit has an electrical resistance configured to convert current passing through the current transformer to voltage, and a circuit through the electrical resistance is formed when the first fixing unit is connected to the second connector of the apparatus main body.

3. The image forming apparatus according to claim **1**, wherein the current detecting circuit has a plurality of electrical resistances configured to convert current passing through the current transformer to voltage, and a circuit in which the plurality of electrical resistances are connected in parallel is formed when the first fixing unit is connected to the second connector of the apparatus main body.

4. The image forming apparatus according to claim **1**, wherein the fixing unit has a tubular film to be heated by the heater.

5. The image forming apparatus according to claim **4**, wherein the heater is in contact with an inner surface of the film.

6. An image forming apparatus comprising:

a fixing unit having a heater configured to generate heat with power supplied from a commercial power supply, the fixing unit being configured to fix an unfixed image formed on a recording material to the recording material with heat from the heater;

a current detecting circuit configured to detect current fed to the heater; and

an apparatus main body configured to accommodate the current detecting circuit,

wherein the fixing unit is attachable to the apparatus main body,

wherein the current detecting circuit detects current fed to the heater through a current transformer that includes a primary side and a secondary side,

wherein a part of the current detecting circuit provided in the secondary side of the current transformer is provided in the fixing unit, and

wherein the apparatus main body has a first connector configured to connect the commercial power supply and the heater in the fixing unit, and a second connector configured to connect the part of the current detecting circuit provided in the secondary side of the current transformer and the current detecting circuit provided in the secondary side of the current transformer provided in the apparatus main body.

7. The image forming apparatus according to claim **6**, wherein the current detecting circuit has an electrical resistance configured to convert current passing through the current transformer to voltage, and a circuit through the electrical resistance is formed when the fixing unit is connected to the second connector of the apparatus main body.

8. The image forming apparatus according to claim **6**, wherein the current detecting circuit has a plurality of electrical resistances configured to convert current passing through the current transformer to voltage, and a circuit in which the plurality of electrical resistances are connected in parallel is formed when the fixing unit is connected to the second connector of the apparatus main body.

9. The image forming apparatus according to claim **6**, wherein the fixing unit has a tubular film to be heated by the heater.

10. The image forming apparatus according to claim **9**, wherein the heater is in contact with an inner surface of the film.

11. A fixing unit attachable to an image forming apparatus, the fixing unit being configured to fix an unfixed image formed on a recording material to the recording material, the fixing unit comprising

a heater configured to generate heat with power supplied from a commercial power supply,

wherein the image forming apparatus has a current detecting circuit configured to detect current fed to the heater through a current transformer that includes a primary side and a secondary side, and

wherein the fixing unit has a part of the current detecting circuit provided in the secondary side of the current transformer, a first connector configured to connect the commercial power supply and the heater in the fixing unit, and a second connector configured to connect the part of the current detecting circuit provided in the secondary side of the current transformer and the current detecting circuit provided in the secondary side of the current transformer provided in the apparatus main body.

12. The fixing unit according to claim **11**, wherein the part of the current detecting circuit provided in the fixing unit has a resistance element.

13. The fixing unit according to claim **11**, wherein the fixing unit has a tubular film to be heated by the heater.

14. The fixing unit according to claim **13**, wherein the heater is in contact with an inner surface of the film.

15. An image forming apparatus comprising:

an apparatus main body to which a first fixing unit having a heater corresponding to a 100 V series commercial power supply and a second fixing unit having a heater corresponding to a 200 V series commercial power supply are exchangeably attachable; and

a current detecting circuit provided in the apparatus main body, the current detecting circuit detecting current fed to the heater in the first fixing unit or the second fixing unit attached to the apparatus main body,

wherein an unfixed image formed on a recording material is fixed to the recording material with heat from the heater in the first fixing unit or the second fixing unit attached to the apparatus main body,

wherein the current detecting circuit detects current fed to the heater in the fixing unit through a current detection electrical resistance provided in a power supply path to the heater,

wherein at least one of the first fixing unit and the second fixing unit has a part of the current detecting circuit, and

wherein the apparatus main body has a first connector configured to connect the commercial power supply and the heater in the first fixing unit or the second fixing unit, and a second connector configured to connect the part of the current detecting circuit and the current detecting circuit provided in the apparatus main body.

16. The image forming apparatus according to claim **15**, wherein the fixing unit has a tubular film to be heated by the heater.

17. The image forming apparatus according to claim **16**, wherein the heater is in contact with an inner surface of the film.

18. An image forming apparatus comprising:

a fixing unit having a heater configured to generate heat with power supplied from a commercial power supply, the fixing unit being configured to fix an unfixed image formed on a recording material to the recording material with heat from the heater;

a current detecting circuit configured to detect current fed to the heater; and

an apparatus main body configured to accommodate the current detecting circuit,

wherein the fixing unit is attachable to the apparatus main body,

wherein the current detecting circuit detects current fed to the heater through the fixing unit through a current detection electrical resistance provided in a power supply path to the heater,

wherein a part of the current detecting circuit is provided in the fixing unit, and

wherein the apparatus main body has a first connector configured to connect the commercial power supply and the heater in the fixing unit, and a second connector configured to connect the part of the current detecting circuit and the current detecting circuit provided in the apparatus main body.

19. The image forming apparatus according to claim **18**, wherein the current detecting circuit has a rectifier diode and capacitor configured to hold a peak voltage acquired resulting from current-voltage conversion performed by the current detection electrical resistance.

20. The image forming apparatus according to claim **18**, wherein the fixing unit has a tubular film to be heated by the heater.

21. The image forming apparatus according to claim **20**, wherein the heater is in contact with an inner surface of the film.

22. A fixing unit attachable to an image forming apparatus, the fixing unit being configured to fix an unfixed image formed on a recording material to the recording material, the fixing unit comprising a heater configured to generate heat with power supplied from a commercial power supply,

wherein the image forming apparatus has a current detecting circuit configured to detect current fed to the heater,

wherein the current detecting circuit detects current fed to the heater in the fixing unit through a current detection electrical resistance provided in a power supply path to the heater, and

wherein the fixing unit has a part of the current detecting circuit, a first connector configured to connect the commercial power supply and the heater in the fixing unit, and a second connector configured to connect the part of the current detecting circuit and the current detecting circuit provided in the apparatus main body.

23. The fixing unit according to claim **22**, wherein the fixing unit has a tubular film to be heated by the heater.

24. The fixing unit according to claim **23**, wherein the heater is in contact with an inner surface of the film.

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